

INDOOR AIR QUALITY ASSESSMENT

**Hatfield Town Hall
59 Main Street
Hatfield, Massachusetts**



Prepared by:
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Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Ellen Bokina Paszek, Hatfield Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at Hatfield Town Hall (the town hall), 59 Main Street, Hatfield, Massachusetts. On March 13, 2003, a visit to conduct an indoor air quality assessment was made to this building by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA.

The town hall was evacuated due to an unidentified odor on March 12, 2003. Building occupants reported a combination of eye and throat irritation, headaches, coughing and dizziness at the time of the incident. The symptoms were of sudden onset and occurred during the mid-day of the aforementioned date. The town hall remained vacant overnight. Mr. Feeney conducted carbon monoxide testing in the building May 13, 2003 beginning around 9:00 AM. No measurable levels of carbon monoxide were detected during the initial entry. After consultation with the Hatfield Board of Health, the Hatfield Fire Department and other Hatfield Town officials, building occupants were allowed to reenter the building mid-morning on March 13, 2003. The building was closed to the public until the following day, March 14, 2003.

The town hall is a two-story, red brick building with a finished basement (the ground floor) that was constructed in 1930. The second floor contains meeting rooms and an auditorium balcony. The first floor contains various town offices and the auditorium. The ground floor contains additional town offices and also serves as the police department and fire department headquarters. A boiler room is also located on

the ground floor. Windows throughout the building are openable and consist of single paned glass set in wooden window frames.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor. Screening for total volatile organic compounds (TVOCs) was conducted using an Hnu Photo Ionization Detector (PID). Air tests for ultrafine particulates were taken with the TSI, P-Trak TM Ultrafine Particle Counter Model 8525.

Results

These offices have an employee population of approximately 10 and are visited by up to 100 members of the public on a daily basis. During the assessment on March 13, 2003, the tests were conducted in two phases. Carbon monoxide sampling was conducted in a vacated building during the initial entry at about 9:00 AM. Upon completion of carbon monoxide testing, general air monitoring was conducted in the morning and afternoon under normal operating conditions. Outdoor carbon dioxide, carbon monoxide, temperature, relative humidity, TVOC, and UFP levels were taken as comparison values. Test results appear in Tables 1-2.

Discussion

Ventilation

In order to identify potential pathways for environmental pollutants to enter the building, an assessment of the town hall's ventilation system was conducted. It can be seen from the tables that carbon dioxide levels were below 800 ppm in all but two areas surveyed, which indicates adequate air exchange in most areas. No general mechanical ventilation systems exist on the first and second floor of the building. Located beneath windows in each room are radiators that provide heat. The sole source of fresh air is through openable windows. The auditorium has a mechanical ventilation system (see Picture 1), however it was deactivated during the assessment. No mechanical ventilation system exists in the basement. With the lack of exhaust ventilation, pollutants that exist in the interior space can build up and lead to indoor air quality/comfort complaints. Only restrooms had motorized exhaust vents.

During summer months, ventilation in the town hall is controlled by the use of openable windows. The town hall was configured in a manner that uses cross-ventilation to provide comfort for building occupants. The building is equipped with windows on opposing exterior walls. This design allows for airflow to enter an open window (windward side), pass through a room, pass through the open door, enter the hallway, pass through the opposing open room door, into the opposing room and exit the building on the leeward side (opposite the windward side) (see Figure 1). With all windows and doors open, airflow can be maintained in a building regardless of the direction of the wind. This system fails if the windows or doors are closed (see Figure 2).

Some offices on the first floor were created by erecting walls beneath the second floor balcony of the auditorium (see Picture 2). These offices have neither a mechanical ventilation system nor windows. Instead, holes were cut into the floor of the balcony and passive vents were inserted for passive ventilation.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 ppm. Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation

and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see [Appendix I](#).

The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature readings were measured in a range of 68° F to 72° F in occupied areas, which were very close to the BEHA recommended comfort range. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was below the BEHA recommended comfort range in all areas surveyed. Relative humidity measurements ranged from 19 to 30 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity in this building would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Relative humidity levels in the building would be expected to drop during the winter months due to heating.

It is important to note, relative humidity measured indoors exceeded outdoor measurements. This increase in relative humidity can indicate that air exchange within the building at the time of the assessment was not sufficient in removing normal indoor air pollutants (e.g. water vapor from respiration). Relative humidity measurements over background can also indicate that a significant moisture source exists (see **Microbial/Moisture Concerns** and the **Other Concerns** sections of this report). Moisture removal is important since the sensation of heat conditions increases as

relative humidity increases (the relationship between temperature and relative humidity is called the heat index). As indoor temperature rises, the addition of more relative humidity will make occupants feel hotter. If moisture is removed, the comfort of the individuals is increased. Removal of moisture from the air, however, can have some negative effects. To reiterate, the sensation of dryness and irritation is common in a low relative humidity environment, especially during the heating season in the northeastern United States.

Microbial/Moisture Concerns

A factor that may be contributing to moisture is water accumulation. The following conditions can lead to water accumulation along the base of the building, which can lead to moisture penetration into the basement:

- Breaches in the foundation: Large penetrations were noted in the foundation wall (see Picture 3) and floor (see Picture 4) in the Fire Department office. These breaches can serve as sources for water entry. In addition, termites had infested wooden baseboards in contact with the floor of the Fire Department (see Picture 5). Termites generally will infest wood that is chronically moistened.
- Location of plant growth: Shrubbery was noted to be in direct contact with the exterior wall brick along the front of the building (see Picture 6). Plants retain water. Shrubbery can serve as a possible source of water impingement on the exterior curtain wall. In some cases, plants can work their way into mortar and brickwork causing cracks and fissures. This may subsequently lead to water penetration and possible mold growth.

Each of these conditions can allow for the accumulation of water along the base of the building, which can lead to moisture penetration into the basement.

Several areas had water-damaged ceiling tiles and wall plaster. Window frames appear to be original and exhibit signs of water damage. Water damage to the interior can result from leakage through window frames. Porous building materials (e.g. ceiling tiles and wall plaster) can serve as growth media for mold, especially if wetted repeatedly. These materials should be replaced after a water leak is discovered.

Other Concerns

Air testing for various materials were taken in different areas of the town hall. To ascertain whether symptoms could be related to exposure to combustion products of fossil fuels, air monitoring for carbon monoxide was conducted. The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for exposure to carbon monoxide in outdoor air. Carbon monoxide levels in outdoor air must be maintained below 9 ppm over a twenty-four hour period in order to meet this standard (US EPA, 2000). No measurable levels of carbon monoxide were recorded at anytime during the assessment.

Fossil fuel combustion or plumbing activities can produce particulate matter that is of a small diameter ($<10\text{ }\mu\text{m}$). These ultra fine particles (UFPs) can penetrate the lungs and subsequently cause irritation. For this reason a device that can measure particles of a diameter of $10\text{ }\mu\text{m}$ or less was used to identify pollutant pathways for potential UFP sources.

The instrument used by BEHA staff to conduct air monitoring for UFPs counts the number of particles that are suspended in a cubic centimeter (cm^3) of air. This type of air monitoring is useful in that it can track and identify the source of airborne pollutants by counting the actual number of airborne particles. The source of particle production can be identified by moving the UFP counter through a building towards the highest measured concentration of airborne particles. Measured levels of particles/ cm^3 of air increase as the UFP counter is moved closer to the source of particle production. While this equipment can ascertain whether unusual sources of ultrafine particles exist in a building or that particles are penetrating through spaces in doors or walls, it cannot be used to quantify and determine whether the NAAQS PM_{10} standard was exceeded. The primary purpose of these tests was *to identify and reduce/prevent pollutant pathways*. Air monitoring for UFPs was conducted in offices, hallways and other areas. For comparison, measurements were taken indoors, as well as outdoors. No significant increased levels of UFPs over outdoor background levels were measured.

In an effort to determine whether chemicals, specifically volatile organic compounds (VOCs), were present in the town hall, air monitoring for aerosolized TVOCs was conducted. TVOCs are groups of substances containing carbon that have the ability to evaporate at room temperature. Frequently, exposure to low levels of TVOCs may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. If a chemical were present and were evaporating at room temperature, the most likely materials would be TVOCs. Indoor TVOC concentrations were taken throughout the building. An outdoor air sample was taken for comparison value, where TVOC concentration outdoors was measured at 0.3 ppm. Indoor TVOC concentrations

either matched or were below outdoor measured concentrations. The men's room in the basement was the exception; here, the source of the TVOC was traced to a deodorizer used in this area.

Based on observations at the time of the assessment, the source of the irritant appears to have originated from the areas adjacent to the basement stairwell. Odors were noticed near the basement stairwell. In close proximity to the base of the stairwell are the boiler room and the basement restrooms. Conditions and activities in these rooms likely generate odors that can become irritants.

Prior to the March 12, 2003 incident, repairs were made to pipes located in storeroom within the boiler room. Spaces were noted in the boiler room door, as well as around pipes that pass through the walls of this area. Spaces and holes of this nature can serve as odor pathways from the boiler room into the hallway and adjacent areas.

A restroom was added between the fire and police department offices. This area appeared to have minimal exhaust ventilation. An air deodorizer was sprayed in this restroom and periodically monitored the room to see if the deodorizer scent would dissipate. The deodorizer scent did not dissipate over the course of an hour, which indicates minimal air movement. Based on these observations it is likely that any odors that accumulate in these restrooms would also linger.

Floor drains and infrequently used sinks in the basement are another potential source of odors. Basement drains did not appear to have recently drained water, which can lead to dry traps. In one area, the floor had drains that were sealed, but were not rendered airtight (see Picture 7). An open drain exists in the fire department office (see Picture 8). A trap forms an airtight seal when water is poured down the drain. A dry

trap can allow for sewer gas to back up into the building. If the drain system were placed under positive air pressure (e.g. heavy rain), odors can be forced up through drains with dry traps. Sewer gas can be irritating to the eyes, nose and throat. Town officials checked with the wastewater treatment facility personnel, who reported no unusual discharges into sewer lines.

A number of pathways that allow for movement of odors between the basement and the upper floors were also observed in the town hall. In order to explain how an airborne irritant may migrate from the basement to upper areas of the building, the following concepts concerning heated air must be understood.

1. Heated air will create upward air movement (called the stack effect).
2. Cold air moves to hot air, which creates drafts.
3. Airflow is created, intended or otherwise, from items that produces heat (e.g. fluorescent light bulbs).
4. As heated air rises, negative pressure is created, which draws cold air to the equipment creating heat.
5. Combusted fossil fuels contain heat, gasses and particulates that will rise in air.

In addition, the more heated air becomes, the greater airflow increases.

6. Airflow created by the stack effect can draw particulates into the air stream.

Each of these concepts can influence the movement of odors from the basement to the upper floors. The initial area where odors were reported was near the stairwell in the basement. Airflow from this area would be in an upward movement, up the stairwells and/or the abandoned dumbwaiter (see Pictures 9 and 10).

Odors were also noticed in other areas. One of the offices created from auditorium space had an acrid odor. This odor was traced to an operating coffee pot that had been recently moved into this office. Evaporating/burning coffee can be an irritant to the eyes, nose and throat.

Conclusions/Recommendations

In view of the findings at the time of the visit, no readily identifiable source of airborne irritants could be identified. Town hall staff has not received any additional reports of symptoms similar to the initial complaint since the BEHA assessment. It appears that a transient source of irritants was released from an unidentifiable source within the building on May 12, 2003. Once released into the interior of the building, the material did not readily dissipate due to the lack of ventilation and configuration of the building. Over night, the material was able to dissipate and became non-detectable. Other conditions within the town hall may have contributed to or enhanced the effect of these materials to create the symptoms reported by occupants.

In view of the findings at the time of the assessment the following recommendations are made:

- 1) Contact the BEHA at 617 624-5757 if the odors/symptoms reappear.
- 2) Ensure that adequate temporary ventilation is used during any building maintenance (e.g. plumbing, painting).
- 3) Seal all abandoned drains in the basement.
- 4) Pour water into all drains in the building twice a week to wet traps.

- 5) Repair the restroom exhaust vent system in the basement. Once repaired, operate the system to remove water vapor and odors from the basement.
- 6) Move coffee maker into auditorium.
- 7) Render all holes in the foundation walls airtight.
- 8) To prevent moisture penetration into the basement, the following actions should be considered:
 - a) Remove foliage to no less than five feet from the foundation.
 - b) Improve the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek and Brennan, 2001).
 - c) Install a water impermeable layer on ground surface (clay cap) to prevent water saturation of ground near foundation (Lstiburek and Brennan, 2001).
- 9) Remove mold colonized/termite infested materials from the basement. Disinfect non-porous surfaces with an appropriate antimicrobial.
- 10) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

- 11) For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at <http://www.state.ma.us/dph/beh/iaq/iaqhome.htm>.

References

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Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

US EPA. 2000. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. <http://www.epa.gov/air/criteria.html>.

Figure 1

Cross Ventilation in a Building Using Open Windows and Doors

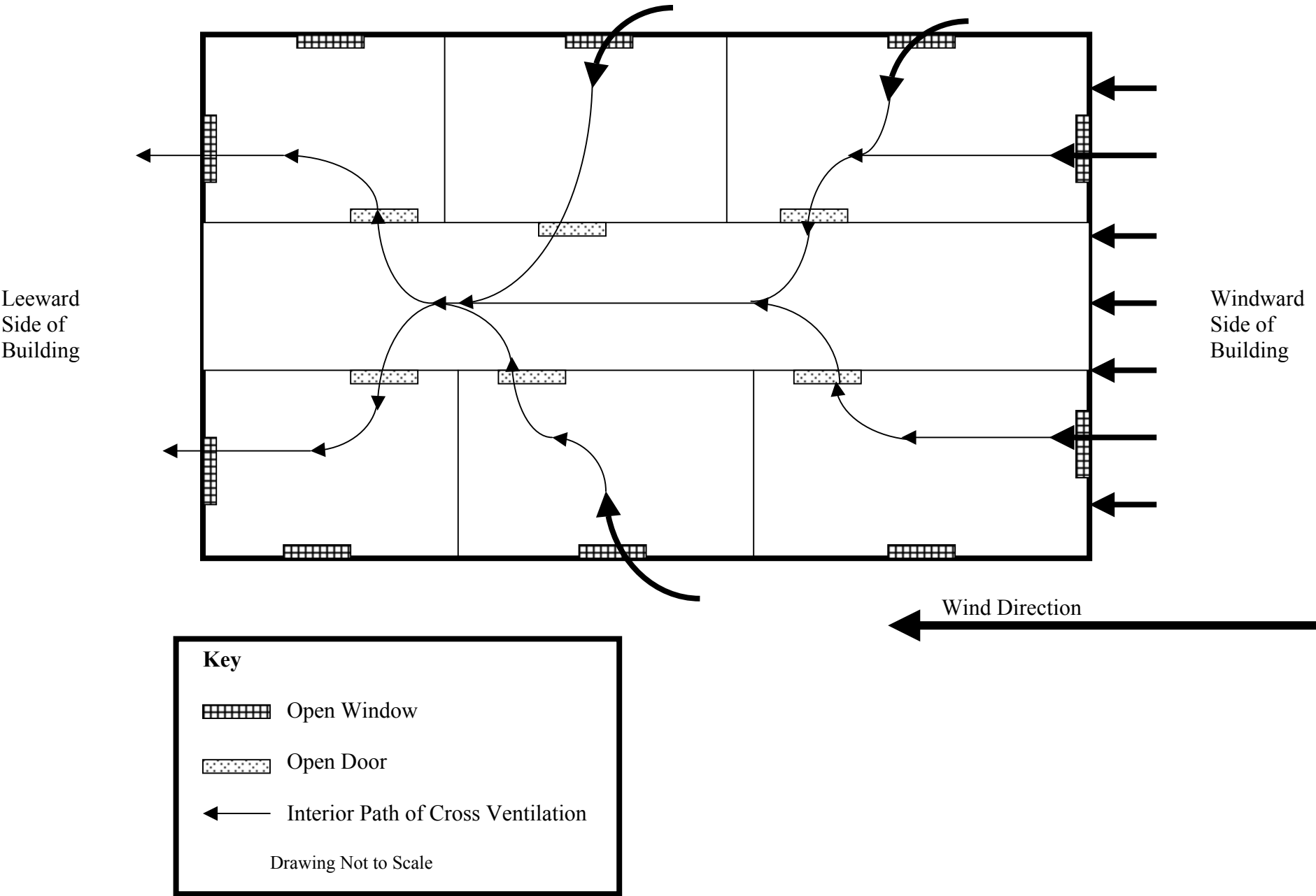
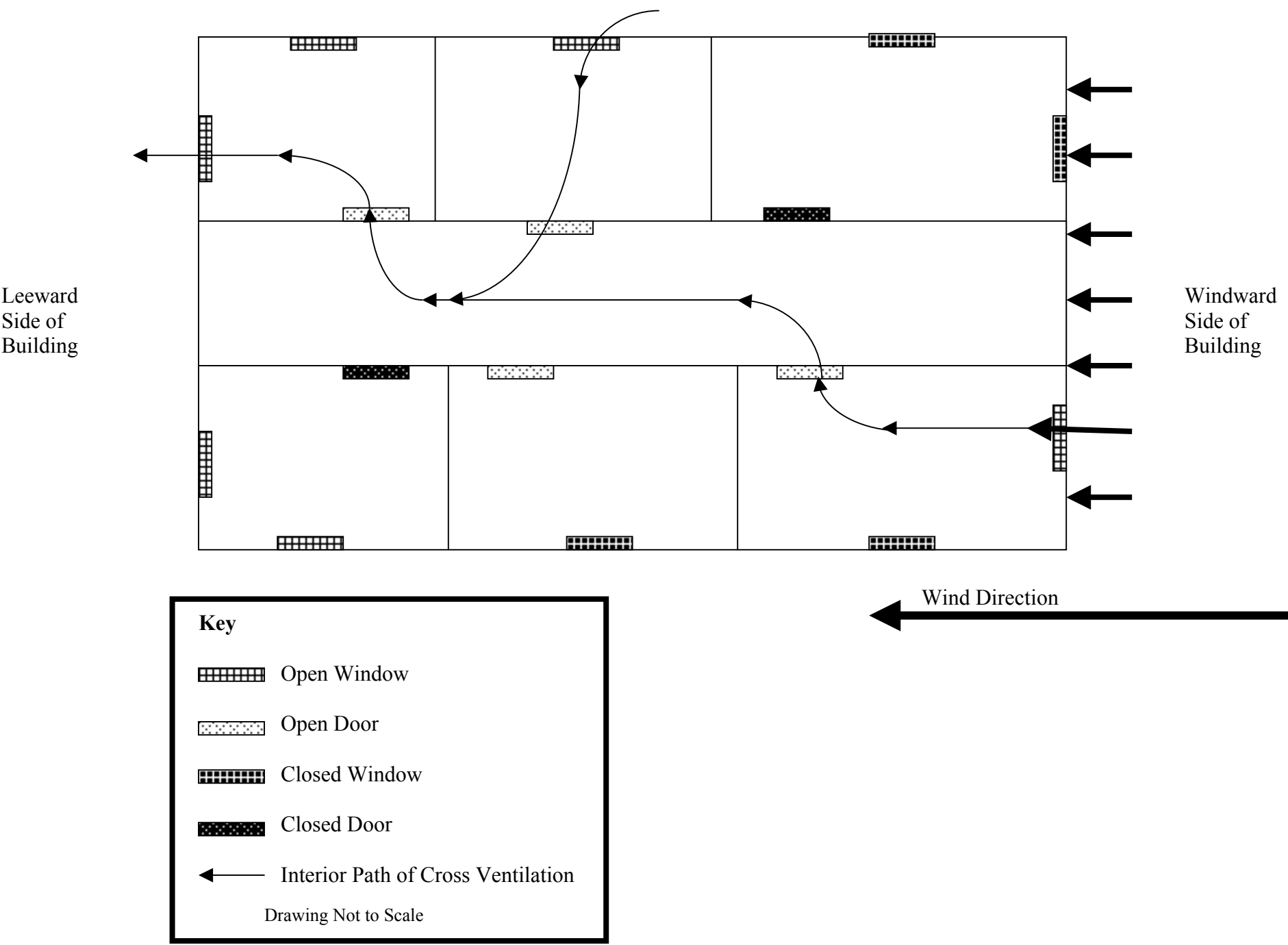


Figure 2

Inhibition of Cross Ventilation in a Building with Several Windows and Doors Closed



Picture 1



Auditorium Ventilation System

Picture 2



Offices Created below Auditorium Balcony

Picture 3



Panel Covering Holes in Foundation Wall in Fire Department Office

Picture 4



Wood Plug Covering Hole in Foundation Floor in Fire Department Office

Picture 5



Termite Infested Baseboard in Fire Department Office

Picture 6



Shrubbery in Direct Contact with the Exterior Wall Brick along the Front of the Building

Picture 7



Capped, but Not Sealed, Drain In Basement

Picture 8



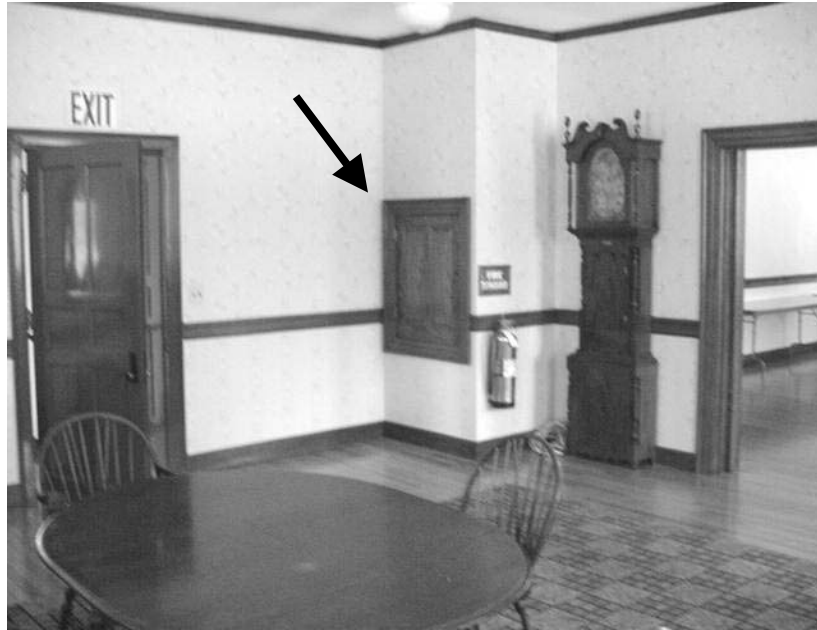
Open Drain in Fire Department Office

Picture 9



Abandoned Dumbwaiter, Basement

Picture 10



Abandoned Dumbwaiter, Second Floor

TABLE 1.1**Indoor Air Test Results – Hatfield, Hatfield Town Hall – AM readings****March 13, 2003**

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Ultra-fine Particulate (**1000p/cc³)	Temp (°F)	Relative Humidity (%)	Remarks
Outdoors (Background)	407	0	0.3	6.3K	45.3	19	
Police Chief	884	0	0.3	2K	69	22.1	
Treasurer, Rm. 101	567	0	0.4	2K	69.1	20.9	
Secretary, Rm. 102	500	0	0.4	2.2K	69.8	19.7	Photocopier
Town Administrator, Rm. 104	619	0	0.4	2K	71.4	21.4	
Gym	431	0	0.3	3.2K	60.6	18.5	
Assessor, Rm. 106	473	0	0.4	1.8K	61.3	29.7	
Upstairs, Rm. 1	616	0	0.3	2.2K	66.6	25.4	Dumbwaiter
Upstairs, Rm. 2	523	0	0.3	2.3K	66.8	24.1	
Balcony	436	0	0.4	3K	60.6	20.6	Floor vent
Upstairs Kitchen	540	0	0.3-0.4	2.3K	64.4	27	Drain 1/Drain 2

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%

TABLE 1.2

Indoor Air Test Results – Hatfield, Hatfield Town Hall – AM readings

March 13, 2003

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Ultra-fine Particulate (**1000p/cc ³)	Temp (°F)	Relative Humidity (%)	Remarks
Top of stairs from basement	557	0	0.3	2.4K	66.6	25.4	
Basement kitchen	527	0	0.4/0.3	2.2K	68.5	69.1	Sink drain, dumbwaiter
Basement – Building Inspector Rm. 5	520	0	---	1.8k	70.8	21.7	
Basement – BOH Rm. 7	514	0	---	2.1K	70	20	
Basement – COA	436	0	0.3	1.9K	69.3	20	chaseway
Basement area	550	0	0.3	2.0K	67.8	20.8	
Basement exit	424	0	0.3	3.8K	51.7	23.2	
Basement – COA office	660	0	0.3-0.4	1.4K	62.6	28.6	Pipe to boiler room
Boiler room	536	0	0.2	2.5K	79	19.7	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 2.1

Indoor Air Test Results – Hatfield, Hatfield Town Hall – PM readings

March 13, 2003

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Temp (°F)	Relative Humidity (%)	Remarks
Police Chief	610	0	---	67.9	25.3	
Treasurer, Rm. 101	660	0	---	68.8	22	
Secretary, Rm. 102	499	0	---	70.3	21.8	Photocopier
Town Administrator, Rm 104	605	0	---	72.1	22	
Gym	470	0	---	57.9	19.9	
Assessor, Rm. 106	586	0	---	71.8	20.8	
Upstairs, Rm. 1	560	0	---	67.2	25.1	
Upstairs, Rm. 2	580	0	---	67.3	26.8	
Balcony	492	0	---	62.2	22.2	
Upstairs Kitchen	572	0	---	67.8	25.8	
Top of stairs from basement	588	0	---	68	24.7	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%

TABLE 2.2**Indoor Air Test Results – Hatfield, Hatfield Town Hall – PM readings****March 13, 2003**

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Temp (°F)	Relative Humidity (%)	Remarks
Basement kitchen	505	0	---	69.1	23.2	
Basement – BOH Rm. 7	520	0	---	68	22.3	
Basement – COA	495	0	---	70.6	22.3	
Basement area	533	0	---	70.4	20.5	
Basement exit	441	0	---	56	21.1	
Basement – COA office	620	0	---	70	22.6	
Boiler room	513	0	---	78.5	23.3	
Basement – janitor storage	549	---	0.3	69.9	21.8	
DPW Director	540	0	0.4	71.6	21.3	
Basement – Fire chief	732	0	0.3	68.7	26.3	Space in wall
Basement hall wall – dumbwaiter	---	---	0.3	---	---	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%

TABLE 2.3**Indoor Air Test Results – Hatfield, Hatfield Town Hall – PM readings****March 13, 2003**

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	Temp (°F)	Relative Humidity (%)	Remarks
Basement – handicap bathroom	589	0	0.3	68.6	24.8	
Basement – men's bathroom	510	0	0.7	68.5	24.3	
Basement – women's bathroom	530	0	0.4	68.2	23.7	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%